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Evaluating Creative Problem Solving with Modular Cube Robotics: A Dual-Process Framework Analysis Across Age

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#CreativeProblemSolving
#STEAM
#EduRobotics
#EducationalRobotics

Problem Statement

- The use of educational robotics to encourage students to participate in STEM subjects is gaining a lot of attention due to its recreational benefits and the chance it presents for them to exercise higher-order thinking skills.
- CreaCube, a modular cube robotics activity provides an immersive approach to STEM education by providing students with a hands-on learning platform where they may design, build, and program robots (Kalmpourtzis & Romero, 2022).
- A recent study by Romero (2022) showed age influences divergent thinking components (e.g., Fluidity, Flexibility, and Originality) along with the time spent while solving ill-defined creative Problems using modular robotics.
- The study's specific goal is to assess the different ways that infants, children, teens, young adults, and Seniors/seniors solve problems, including time, fluidity, flexibility, and originality.
- We aim to better understand the developmental differences in CPS educational robotic tasks to identify the age difference in CPS. This understanding will support the development of age-appropriate educational robotics for different age groups and also encourage learners of different ages to be creative.

Purpose of the Study

- ❖ to examine and compare individuals' ill-defined CpScapacities across different age brackets when engaging with modular cube robotics.
- ❖ to evaluate the solutions' *time*, *fluidity*, *flexibility*, and *originality* demonstrated by infants, children, teens, young adults, and seniors.
- ❖ By scrutinizing these diverse age groups, the study seeks to uncover patterns, variations, or distinctions in problem-solving techniques concerning modular cube robotics from the lens of the dual-process framework. The study aims to study age-related CPS employed with modular robotics. Specifically, the study aims to identify and analyze age-related patterns in problem-solving strategies employed with modular cube robotics to uncover variations among age cohorts and between the two instances of the CreaCube task.

Methodology

Procedure

The CreaCube task is a CPS task designed for participants to construct an independent moving vehicle using four modular robotic cubes chosen from the Cubelets toolkit (Romero & Barma, 2022). The modular robotic cubes—each denoted by a distinct color—serve specific functions: the white cube with wheels for movement represents *'drive affordance'*, the blue cube is an energy source powered by a switch button, the black cube includes a *'distance sensor affordance'*, and the red cube embodies an *'inverter signal affordance'* (Kalmpourtzis & Romero, 2022).

Participants were presented with ill-defined CPS task involving modular cube robotics. They had to arrange the four cubes of different colors and in various ways, each with a distinct functional feature so that the cubes could move independently together in dissonance with the task's goal without using any language or drawings to exhibit their ideas (Romero et al., 2019).

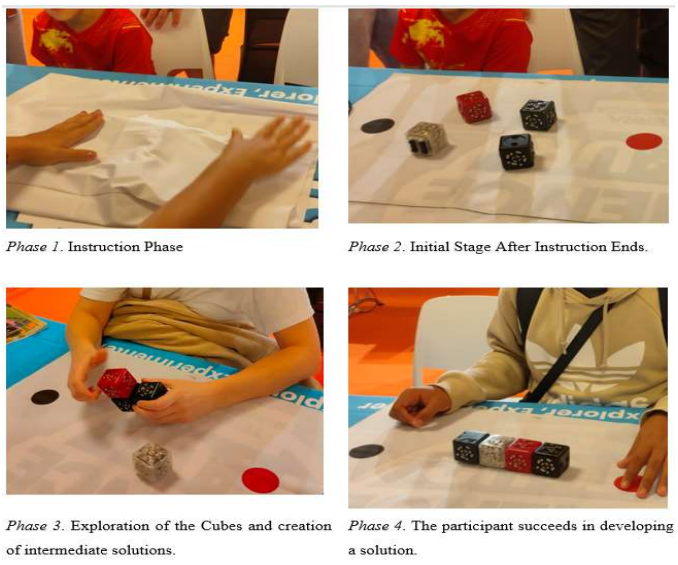
Participants

- ❖ We included 17 individuals, and the following age groups were used to evaluate the data: Infants (0 to 6 years old), children (7 to 12 years old), teens (13 to 18 years old), young adults (19 to 29 years old), and Seniors (60 to 79 years old) are the age groups that are included in this list.
- ❖ Although the age limit of infants is 0 to 6 years, the participants were no less than 5 years.
- ❖ No participant was found to have prior experience with a similar task using modular cubelet robotics. Based on the consent given, the sample participants were recorded for the study purpose.

Data Collection.

Video recordings, observational notes, and coding systems intended to measure problem-solving metrics were all used in the data collection process.

Figure 1. *Four Modular Cubelets Offered to Solve Ill-Defined Creative Problem*



Phase 1. Instruction Phase
Phase 2. Initial Stage After Instruction Ends.
Phase 3. Exploration of the Cubes and creation of intermediate solutions.
Phase 4. The participant succeeds in developing a solution.

Figure 2. *Four phases of the CreaCube task*

Findings

Table 1
Analysis of the first instance of the CreaCube ta

Age Groups=N		Time (Seconds)	Fluidity	Flexibility	Originality
Infants= 2	Mean	150.5	3.5	2	1
	SD	67.18	0.71	1.41	0
Children=9	Mean	93.33	2.67	1.11	0.11
	SD	70.90	1.87	0.33	0.33
Teen=2	Mean	111	2	1	0
	SD	66.47	1.41	0	0
Young Adult=2	Mean	54	1	1	0
	SD	2.83	0	0	0
Senior=2	Mean	96	1.5	1.5	0
	SD	97.58	0.71	0.71	0
Total=17	Mean	**97.82**	**2.35**	**1.24**	**0.18**
	SD	**65.48**	**1.58**	**0.56**	**0.39**

Key Findings-
--Infants, children, and Seniors tend to take more time than teens and younger adults.
--Infants and children showed higher fluidity than other age groups.
--Infants and Seniors showed higher flexibility than other age groups.
--Infants and children showed originality which was absent in other age groups' outcomes.

Table 2
Analysis of the first instance of the CreaCube task

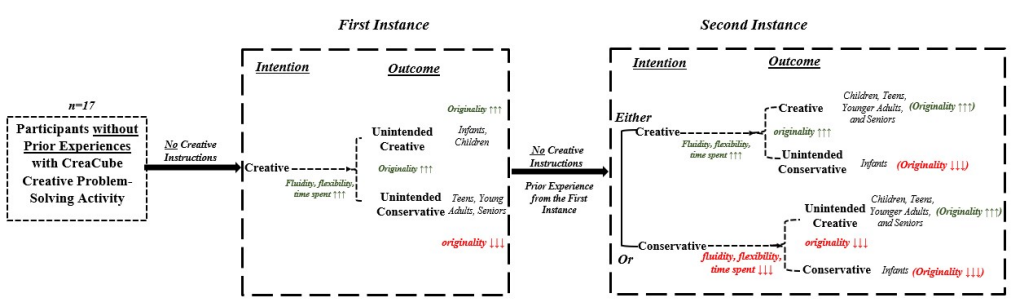
Age Groups= N		Time (Seconds)	Fluidity	Flexibility	Originality
Infants= 2	Mean	21	0.5	0.5	0
	SD	29.70	0.71	0.71	0
Children=9	Mean	41	1.56	0.89	0.11
	SD	35.51	1.42	0.33	0.33
Teens=2	Mean	42	1.5	1	0.5
	SD	15.56	0.71	0	0.71
Young Adults=2	Mean	99	3	1.5	1
	SD	97.58	1.41	0.71	1.41
Seniors=2	Mean	29.5	1	1	0.5
	SD	2.12	0	0	0.71
Total=17	Mean	**48.06**	**1.71**	**1**	**0.29**
	SD	**44.75**	**1.40**	**0.5**	**0.59**

Key Findings-
--Infants and Seniors spent less time and try to solve the problem quickly by recalling where children, teens, and young adults tend to think and try more ideas, therefore spending more time.
--Teens, young adults, and Seniors showed more originality whereas children remained the same as the first instance of the task in this measure.

Visual Representation of the Findings through the Lens of the Dual-Process Model

Figure 3

Visual Representation of the Findings through the Lens of the Dual-Process Model



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